Design Analysis And Fabrication Of 4-Stroke Hero-Honda S.I Engine Piston Using A356/Sic/Flyash Reinforced Composite Material

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Abstract: **This paper presents the fabrication of piston using hybrid composites with aluminum matrix A356 alloy, reinforced with silicon carbide (SiC) and Fly ash. Newly formed A356/FA/SiC hybrid composites are the grouping of the two different hybrid materials. Dry sliding wear tests are conducted on pin-on disc wear testing machine and the frictional effects are analyzed. A 3D model of the Piston used in a two wheeler is designed and modeled in 3D modeling software CATIA and imported the model into Ansys. Finite element analysis is performed on the Piston using the material Aluminum 356 and to determine stresses and temperature effects.**

Keywords: **A356 Alloy; CATIA Software; Finite element analysis;**

I. INTRODUCTION

The phrase composite material has several meanings based on various literatures; one of them is the combination of dissimilar multifunctional material systems that provide excellent properties which are not possible in singular systems. Initial studies were made with process improvement using fiber reinforcement, Anisotropy, high fabrication costs and restricted secondary treating has guided to the use of short fiber / particulate / whisker reinforced composites. The mixture of good transverse properties, low cost, high workability and large increase in performing over unreinforced alloys are the commercially good-looking features of these discontinuous reinforced composites. Compared to dispersion toughened systems, particulate reinforced composites have coarse size reinforcement (1- 100 µm) in comparatively high weight elements (1-30%). In particulate composites, both matrix and reinforcement bear substantial weight. In addition, matrix strengthens as affected by precipitation and dislocation strengthening plays an important role in the load bearing ability of these composites. Metallic matrix composites strengthened with ceramic particles are generally used due to their high particular modulus, strength and wear resistance.

II. LITERATURE REVIEW

On account of the excellent physical, mechanical properties of MMCs, they are applied widely in aircraft technology, electronic engineering and automotive industries. Of all the commercial aluminium alloys, A356 is quite popular choice as a matrix material to prepare metal matrix composites. Several researchers have investigated aluminium matrix composites.

J.B Rao et.al (2013) investigated the deformation behavior of A2024 Flyash composites, and it was seen that the incorporation of Flyash particles to 2024 alloy contributes to improve the mechanical properties and wear properties. Gui (2001) observed that Plasma spraying is a feasible route to produce aluminium composite coatings reinforced with SiC particles. A considerably uniform distribution of SiC particles can be found in the composite coatings. Good compatibility and strong bonding between the sprayed layer and the substrate were obtained. Because of non-wetting nature of graphite by molten aluminium, non-coated graphite particles exhibited an inhomogeneous distribution in the coatings and had a certain loss during plasma spraying. Al/SiC and Al/Gr had clear interfaces, and undesirable reactions were not found. Lin et al (2010) investigated the 10%SiCp/Al-Mg composites by semi-solid mechanical stirring technique. The distribution of SiCp reinforcement in matrix is improved by the superior wettability between reinforcement and matrix, with increasing Mg content. The composites exhibited superior tensile strength compared with Al-Mg alloys. In addition, the mechanical properties of the composites increased with the addition of Mg content.

III. MATERIALS

3.1A356 lloy

A356 alloy was procured from M/s Venuka Industries Hyderabad as 20 kg ingots,

Table 1: Chemical composition of A356 alloy, wt. %.

Si	Mg	Cu	Ti	Zn	Fe	Al
6.5	0.4	0.05	0.06	0.03	0.09	Balance

3.2 Fabrication of Piston material

In the present investigation, aluminium based composites containing 5, 10 and 15wt% SiC and Flyash particulates of 53µm were successfully synthesized by vortex method. The matrix materials used in this study was Al-Si alloy (A356) whose chemical composition was shown in table 1.

Figure1 Sand casting of Piston

Figure2 Machining of Piston

Figure3 Finished part of piston

3.3 Dry Sliding Wear Tests

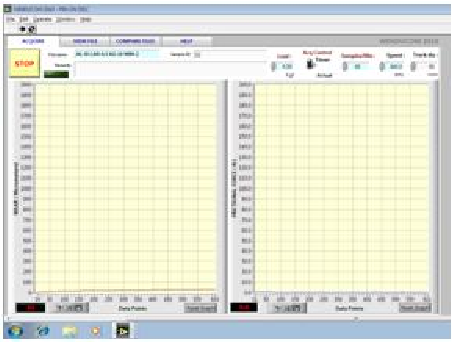
Dry sliding wear tests have been carried out on a pin- on - disc apparatus (Model: Ducom TR- 20 LE) by sliding a cylindrical pin against the surface of hardened steel disc (with a hardness value of HRC 62) under ambient condition. The disc was ground to a smooth surface finish and renewed for each test. For each load, the volume loss from the surface of each specimen was determined as a function of sliding distance and applied load. The wear rate (K) was defined as the volume loss (V), divided by the sliding distance (L). Hence, the volumetric wear rate (K) was calculated from the weight loss measurement and expressed in terms of mm^3/km.

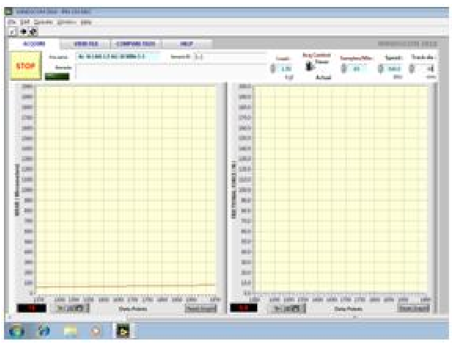
IV. RESULTS AND DISCUSSION

Figure 4 shows the sliding wear behavior of AA 356 alloy composites. The normal load applied was 0.5 Kgf. The wear test was conducted for a period of 30 min at a sliding speed of 640 rpm on a steel disc with 110 mm track diameter and the track velocity was 2.0 m/sec. In all the results it was evident that the resistances to wear increases with increasing FA/SiC particulate content. With increasing FA/SiC particulate content, the amount of particle present strengthens the matrix and hence more wear resistance was observed. The MMCs with lower weight fractions of FA/SiC particulate underwent large wears, and the wear increased almost linearly with time. The base metal exhibits higher wear, and the MMCs with 10% fly ash showed lower wear. The presence of FA/SiC particulate particles in AA 356 alloy matrix might be reason for the lower wear losses for composites compare to base alloy. With increasing normal load, MMCs underwent a transition from mild to severe wear.

J.Babu Rao et.al, has studied the dry sliding wear behaviour of Fly-Ash as a reinforcement and A2024 alloy as a base material. In all the results it was evident that the resistances to wear increases with increasing fly ash content. With increasing fly ash content, the amount of particle present strengthens the matrix and hence more wear resistance was observed

M. Ramachandra et al has also observed the same trend of decreasing the coefficient friction with both the increasing FA/SiC particulate content and also at higher applied loads. The decrease of coefficient of friction with increase of the load may be attributed to increasing amounts of wear debris particles coming out from the wear surface and filling in the empty spaces between FA/SiC particulate particles, thereby decrease in the effective depth of penetration.





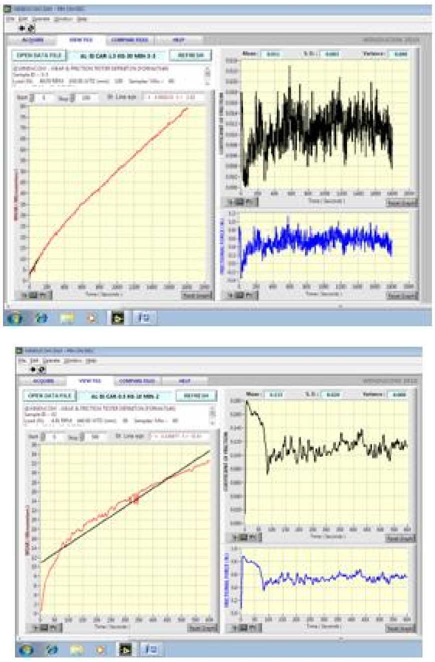


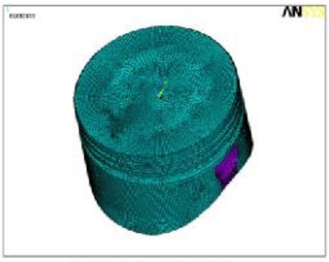
Figure 4 Wear data for Alloy and composites

ANALYSIS OF PISTON

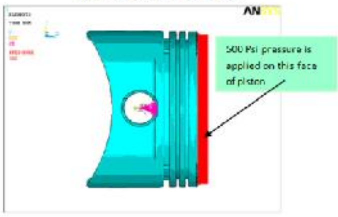
Before analyzing the piston by using the software the stresses developed in the piston are:

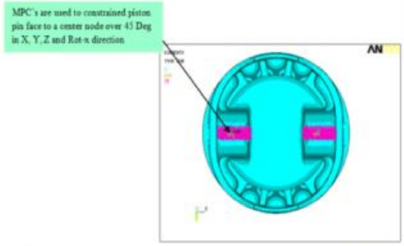
The piston head has to with stand the straining action due to pressure of explosion inside the engine cylinder. The piston rings should have enough strength to with stand radial pressure to maintain the seal between the piston the cylinder bore. The piston skirt should with stand side thrust of the connecting rod and so it should act as bearing. The maximum thrust will be during the expansion stroke. The center of piston pin should with stand the turning effect of the friction and to obtain uniform distribution of pressure between the piston and the cylinder liner. It should also bear the maximum gas load or the inertia force of the piston.

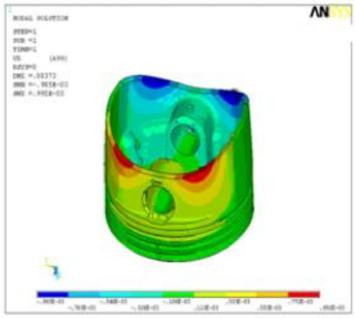
MESHED VIEW OF THE PISTON

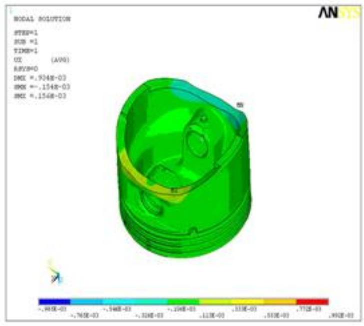


BOUNDARY CONDITIONS

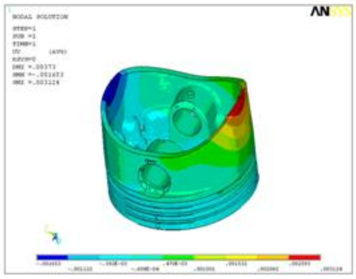


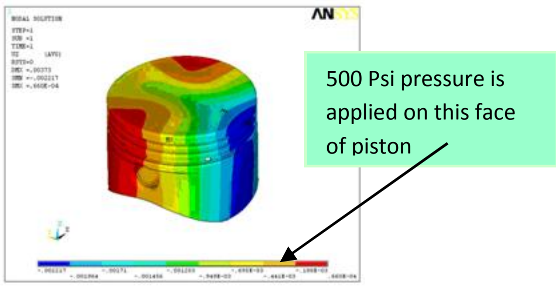






DEFLECTION IN Y-DIRECTION:





The stresses are calculated and the results are tabulated below are in good agreement with analytical values .The von-misses stresses are calculated and the max. stresses acting on the given and the stresses acting at the various directions.

Hence the material, which we have used for the analyzing for the piston is suitable.

V. CONCLUSIONS

Piston was fabricated using A356/FA/SiC particulate composites successfully. From the SEM figures, it clearly shows that there were no voids and discontinuities in the composites; there was a good interfacial bonding between the particles and matrix phase. The hardness of the composites increased with increasing the amount of FA/SiC than the base alloy. In all the results it was evident that the resistances to wear increases with increasing FA/SiC particulate content. The Metal matrix composites (MMCs) with lower weight fractions of FA/SiC particulate underwent large wears, and the wear increased almost linearly with time.

VI. REFERENCES

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